

University of Dundee

Effectiveness of the use of implementation intentions on reduction of substance use

Malaguti, Amy; Ciocanel, Oana; Sani, Fabio; Dillon, John F.; Eriksen, Ann J.; Power, Kevin

Published in:
Drug and Alcohol Dependence

DOI:
[10.1016/j.drugalcdep.2020.108120](https://doi.org/10.1016/j.drugalcdep.2020.108120)

Publication date:
2020

Licence:
CC BY-NC-ND

Document Version
Peer reviewed version

[Link to publication in Discovery Research Portal](#)

Citation for published version (APA):

Malaguti, A., Ciocanel, O., Sani, F., Dillon, J. F., Eriksen, A. J., & Power, K. (2020). Effectiveness of the use of implementation intentions on reduction of substance use: A meta-analysis. *Drug and Alcohol Dependence*, 214, [108120]. <https://doi.org/10.1016/j.drugalcdep.2020.108120>

General rights

Copyright and moral rights for the publications made accessible in Discovery Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from Discovery Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Effectiveness of the use of implementation intentions on reduction of substance use: a meta-analysis.

Amy Malaguti^{*a,b,c}, Oana Ciocanel^{b,c}, Fabio Sani^{a,1}, John F. Dillon^{d,e,2}, Ann Eriksen^c and Kevin Power^{b,f}.

^a *School of Social Sciences (Psychology), University of Dundee, Scrymgeour Building, Park Place, Dundee, DD1 4HN, United Kingdom.*

^b *Adult Psychological Therapies Service, NHS Tayside, 15 Dudhope Terrace, Dundee, DD3 6HH, United Kingdom.*

^c *Sexual Health and Blood Borne Virus Managed Care Network, Public Health Directorate, NHS Tayside, Kings Cross Hospital, Dundee, DD3 8EA, United Kingdom.*

^d *School of Medicine, Ninewells Hospital, University of Dundee, DD1 9SY, Dundee, United Kingdom.*

^e *Department of Gastroenterology, NHS Tayside, Ninewells Hospital, Dundee, DD1 9SY, United Kingdom.*

^f *Faculty of Natural Sciences (Psychology), University of Stirling, Stirling, FK9 4LA, United Kingdom.*

*Corresponding author: Ms Amy Malaguti, Orcid ID: 0000-0003-0903-5448, Email: a.malaguti@dundee.ac.uk, School of Social Sciences (Psychology), University of Dundee, Scrymgeour Building, Park Place, Dundee, DD1 4HN, United Kingdom.

¹Fabio Sani's Orcid ID: 0000-0003-1578-5472

²John F. Dillon's Orcid ID: 0000-0002-2164-4476

Effectiveness of the use of implementation intentions on reduction of substance use: a meta-analysis.

ABSTRACT

Objective: *Background:* Substance use, such as alcohol drinking, tobacco smoking and illicit drug use, have been associated with severe health conditions and an annual estimated 12% of all deaths worldwide. Implementation intentions are self-regulatory processes which help achieve health-related behaviour change. *Objectives:* To investigate the effectiveness of forming implementation intentions to reduce substance use.

Design: *Data sources:* PsycINFO, MEDLINE, Psychology and Behavioural Science Collection, clinicaltrials.gov, UK Clinical Trials Gateway, Reference lists. *Inclusion criteria:* RCT of substance users forming implementation intentions to reduce consumption (active or passive control condition present). *Study appraisal and synthesis methods:* the SIGN checklist for RCT quality was used for quality appraisal, data was extracted by two reviewers.

Results: Twenty-one studies were included in the meta-analysis. The overall effect size for alcohol use was $g=0.31$ (95% CI: 0.21, 0.42), $p<.001$; for tobacco smoking $g=0.31$ (CI: 0.12, 0.5), $p=.002$; no studies were retrieved for the use of implementation intentions on illicit drug use.

Conclusion: This review suggests that implementation intention interventions are effective in reducing some forms of substance use (alcohol use and tobacco smoking), albeit revealing small effect sizes, among the general population and students in secondary and higher education. *Review registration number:* CRD42018116170.

Keywords

Implementation intentions, substance use, alcohol, tobacco smoking, behavior change.

1 Background

Commonly consumed psychoactive substances such as alcohol, nicotine and opioids have been associated with a number of health conditions (World Health Organisation - WHO,

2018a) and an estimated yearly 12% of all deaths worldwide (Hodder et al., 2016), amounting to around 11 million deaths a year.

Alcohol consumption is linked to both acute and chronic poor health outcomes (and related mortality) such as injuries, hepato-gastroenterological diseases, cardiovascular disease, infectious diseases and cancers (Bahorik et al., 2017; Schuckit, 2009; WHO, 2018a).

Smoking of tobacco is the single leading cause of preventable deaths around the world.

Cardiovascular disease, cancers, chronic respiratory disease, diabetes have all been linked to tobacco smoking (WHO, 2014a). Illicit drug use disorders have been linked to increased mortality and other poor health outcomes, such as arthritis, chronic pain, bacterial and viral infections (HIV and hepatitis C), cardiovascular disease, poor mental health (e.g. suicidality, anxiety and depression), chronic pulmonary disease, respiratory and other cancers (Bahorik et al., 2017; WHO, 2016).

In the proceeding paragraphs, the association between substance use and health is investigated and categorised by substance.

1.1 Implementation intentions to promote health behaviour

Implementation intentions are self-regulatory processes which take the form of ‘if-then’ plans and facilitate the attainment of goals and behaviour change (Gollwitzer, 1993). The role of intentions in behaviour change has been explored within a variety of theories and models of behaviour change, e.g. Ajzen’s Theory of Planned Behaviour (1991). Previous research shows that action planning interventions (implemented either as a once-off intervention or as repeated sessions) can be helpful in reducing substance use behaviours in both populations with diagnosed addictions (Latka et al., 2008; Robles et al., 2004) and the general population (Bolman et al., 2015).

Implementation intentions have been used to recognise contextual barriers and to plan in detail how to achieve a goal: when, where and how to perform a specific behaviour. They

take the form of if-then plans: “if Y happens then I will perform Z”, which commits individuals to behave in a particular way (Z) when they are presented with a certain situation (Y) (Gollwitzer, 1993). This provides the individual with self-regulatory strategies that create heightened accessibility of environmental cues, allowing individuals to automatically respond to contextual cues by unconsciously initiating their planned behaviour (Aarts et al., 1999; Gollwitzer, 1993). Implementation intentions are specifically mentioned in the Behaviour Change Technique Taxonomy (Michie et al. 2013) as a theoretical framework within action planning. Action planning in the taxonomy is the technique 1.4, part of Group 1: Goals and planning. It requires prompt detailed planning, including context, frequency, duration and/or intensity, of performance of a behaviour, and the context can be environmental or internal (Michie et al. 2013). Implementation intentions interventions can assume a variety of different formats. Type of implementation intentions can be oral or in writing, on paper or on screen (sometimes online), self-generated by people completing the intervention or pre-specified by the researchers or clinicians, or pre-specified situation and self-generated solutions (Armitage 2009; Armitage 2015; Caudwell et al. 2018; Hagger et al. 2012a).

A number of studies have investigated the effects of implementation intentions on health-related behaviours. A medium to large effect size of $d = 0.65$ was reported in a meta-analysis of behaviour change studies (Gollwitzer and Sheeran, 2006). Implementation intentions are a short and inexpensive intervention which could benefit people misusing substances and their effectiveness for such behaviours needs to be examined.

Numerous systematic reviews and meta-analyses have been carried out on the effectiveness of implementations intentions (Adriaanse et al., 2011; Bélanger-Gravel et al., 2013; Gollwitzer and Sheeran, 2006). No reviews to date have been solely focused on substance use and this review aims to rectify the lack of evidence on this topic.

1.2 Objectives

This review's objective was to investigate the effectiveness of forming implementation intentions to reduce substance use in students and the general population. It aimed, in more detail, to answer the following questions:

1. Does forming implementation intentions reduce alcohol consumption?
2. Does forming implementation intentions reduce tobacco smoking?
3. Does forming implementation intentions reduce illicit drug use?

2 Methods

The methodology and reporting of this review comply with the PRISMA statement checklist for reporting of systematic reviews and meta-analyses (Moher et al., 2009), with the Meta-Analysis Reporting Standards – MARS (American Psychological Association, 2008) and with the Scottish Intercollegiate Guidelines Network (SIGN) checklist 1: systematic reviews and meta analysis (SIGN, 2018). The review protocol with methods and inclusion criteria was registered in advance on the University of York's Centre for Reviews and Dissemination PROSPERO register, as CRD42018116170.

2.1 Eligibility Criteria

Only studies written in English were considered for selection, with no limit on publication dates on the first searches carried out between April and September 2018. An update search was run in January 2019, to which restricted publication dates were applied between 2018 and 2019 only. No geographical restrictions were applied.

2.1.1 Participants

No restrictions were applied to study participant characteristics.

2.1.2 Interventions

The intervention under review was the formation of implementation intention for the reduction of substance use behaviours, such as tobacco smoking, drinking alcohol, and other drug use. Trials with more than one intervention were selected when the implementation intention was reported independently so that the effect could be measured independently.

2.1.3 Comparisons

All studies had to present a control group. This included passive control groups (not performing any task) and active controls (performing an unrelated time-control task such as filling in an extra questionnaire or creating implementation intentions for an unrelated behaviour).

2.1.4 Outcomes

All studies were required to report on substance use as their main outcome measures.

2.1.5 Study Design

Randomised controlled trials (RCTs) were selected for review. Intervention follow-up length was left unrestricted for selection.

2.2 Information sources

The following databases were searched between April 2018 and September 2018 via EBSCOhost: PsycINFO, MEDLINE and Psychology and Behavioural Science Collection. Reference lists of all selected papers for screening were searched by hand between September and October 2018. The following clinical trial registers were searched in November 2018: Clinicaltrials.gov and UK Clinical Trials Gateway.

2.3 Search and Study selection

The search strategy was similar across all databases, adjusting for database-specific headings.

An example of the search strategy for PsycINFO is provided in Supplementary File 1.¹

Reference lists were searched by hand for relevant titles; whilst research registers were searched with “implementation intentions” in the title or trial description.

One reviewer carried out the full search on the three different databases via EBSCOhost.

Searches were saved in an EBSCOhost folder. All selected titles were transferred into the reviewer’s EBSCOhost list. Duplicates were removed manually.

2.4 Data collection process and items

Data was extracted by 2 reviewers together, both chartered health psychologists, and inputted into a summary table then transferred into the Comprehensive Meta-Analysis Software v3.3.

The data extracted (See Table 1) were study design (including control group format), follow up period, sample characteristics (sample size, age, sex, students or general population), theoretical approach, behavioural goal (reduce alcohol consumption, reduce tobacco smoking or reduce drug use), implementation intentions format (online or pen & paper, pre-specified or self-generated, number of plans), outcome measures of substance use reduction (units/day, binge drinking occasions, cigarettes/day, tobacco smoking quitting status) and effect size (Hedge’s *g* with specified 95% Confidence Intervals, See section 2.7 for effect size calculation). For 10 studies, the authors were contacted for data or data clarification. Eight replied and further information was provided for 5 studies.

2.5 Risk of bias in individual studies

Risk of bias in individual studies was assessed with the SIGN checklist 2 for randomised controlled trials (SIGN, 2018). This checklist assesses selection bias, ascertainment bias, measurement bias, attrition bias and reporting bias. Agreement for assessment of individual

¹ Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi: ...

studies by different reviewers was calculated using Cohen's kappa coefficient of inter-rater reliability (McHugh, 2012).

2.6 Statistical analyses

The Comprehensive Meta-Analysis software (version 3.3) was used to perform all calculations, test for heterogeneity and generate forest plots. Given the assumed heterogeneity in interventions, populations and outcomes, a random-effects model was selected (Hedges and Vevea, 1998).

2.7 Effect size calculations

For *continuous outcomes* (alcohol use and smoking) Hedges' g with 95% confidence intervals (CIs) were calculated as the difference between the intervention group's mean follow up scores and the comparison groups' mean follow up score divided by the pooled standard deviation and adjusted for sample size. Hedges' g corrects for small sample sizes (Borenstein et al., 2009).

For *dichotomous outcomes* (e.g. percentage of people who quit smoking, group differences in abstinence) we calculated the risk ratio (RR) and 95% confidence intervals (CIs) on the basis of the number of events and the number of participants in the intervention and control groups. We then transformed these (using meta-analysis software) to g statistics to allow for comparisons across studies (Borenstein et al., 2009).

In studies where the primary outcome was investigated with more than one measure (i.e. alcohol units consumed per week and binge drinking occasions or cigarettes smoked per day and nicotine dependence score) results were combined into a single overall outcome mean effect size (i.e. alcohol use or smoking) using the Comprehensive Meta-Analysis Software v3.3. This allowed for a more comprehensive meta-analysis, and heterogeneity checks were performed during the analysis to ensure validity of outcomes (Puhan et al., 2006).

Alternative statistics (e.g. F-statistic, odd ratio or p-value and sample size) were used to calculate Hedge's g when studies did not provide means, standard deviations and proportions (Borenstein et al., 2009).

Effect sizes were coded so that positive scores signified favourable intervention effects such as lower alcohol use or smoking, with values of 0.20 considered small effects, 0.50 as medium and 0.80 as large (Cohen, 1988).

2.8 Assessment of heterogeneity

The I^2 and Q statistic tests were used to analyse heterogeneity between studies. I^2 indicates the heterogeneity percentage across the studies (Higgins, 2011). Sensitivity analyses were performed to explore potential sources of heterogeneity.

2.9 Assessment of publication bias

Three techniques were used to determine the extent to which publication bias impacted on the results of the overall sample. Funnel plots were created to explore the presence of publication bias. The Egger regression asymmetry test and the Begg and Mazumdar adjusted rank correlation test (Begg and Mazumdar, 1994) were performed to measure the extent of the funnel plot asymmetry, with $p < 0.05$ indicating a statistically significant publication bias. Finally, the Duval and Tweedie's trim-and-fill method (Duval and Tweedie, 2000), in which the studies are 'trimmed' from the right of the funnel plot and entered on the left side to address funnel plot asymmetry, was used to formalise the result of the funnel plot.

2.10 Sensitivity analyses

Sensitivity analyses were performed to determine the robustness of intervention effects by evaluating whether the overall effect size was sensitive to inclusion of any individual study (Higgins and Green, 2011).

3 Results

3.1 Study selection

AM screened 1756 titles and selected 79 relevant results for abstract selection. Abstracts were again screened by the same reviewer, who selected 29 relevant studies according to the eligibility criteria. Full-texts of 12 studies were excluded with reason and 18 were selected for quality appraisal and inclusion in this study (see supplementary file 2).²

A further 9 studies were found via reference lists searches, 2 excluded after abstract screening, 3 excluded after full-text assessment with reason, and 4 selected for quality appraisal. An extra 2 studies were selected for abstract screening after searching Clinicaltrials.gov and UK Clinical Trials Gateway. One was retained for full-text assessment and included in this study.

After re-running the searches in January 2019, an extra 104 studies were screened by title, 8 selected for abstract screening, 4 were removed as duplicates and 3 selected for full-text screening. All 3 were excluded with reason (see supplementary file 2).³

Overall, a total of 1906 were identified in the search for this review, 94 were screened through their abstract, 40 selected for full-text assessment, 18 excluded with reason (See supplementary file 2)⁴, 22 selected for quality appraisal, and 21 included in the meta-analysis (See Figure 1). One study was included in the qualitative synthesis but excluded from the meta-analysis (Conner and Higgins, 2010). The study presented interval follow-up period of 4 to 48 months; however, the authors, after being contacted for unadjusted 4 months follow-

² Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi: ...

³ Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi: ...

⁴ Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi: ...

up data, suggested the exclusion of their paper on the basis of the multi-level nature of their data.

3.2 Characteristics of the studies

Among the 22 studies selected for the review, 15 studies were RCTs on interventions to reduce alcohol consumption, whilst the remaining 7 RCTs aimed at reducing cigarette smoking (See Table 1). One paper (Armitage and Arden, 2016) reported 2 different studies, which were treated as separate studies for the analysis, whilst another divided results by nationality of the sample (Hagger et al., 2012b) bringing the total number of studies reviewed for the alcohol use outcome to 18. All studies had suitable explanation about the randomisation procedure, albeit details on which online software or website was often missing. All studies reported behavioural outcomes.

The two main outcome analyses were run on studies with a follow-up of between 2 weeks and 3 months ($k=19$), with a mean follow-up period of $M=5.68$ weeks ($SD=4.8$). These were all considered short follow-up timeframes, given healthy habits tend to require around 6 months to become established (Armitage et al., 2011).

The papers selected for the meta-analysis ($k=21$) reported an initial samples total of $N=6655$. The analysed sample total was 2758, with some papers performing an intention-to-treat analysis ($k=13$). Some of the studies selected were comparing control conditions to implementation intention groups and other intervention groups, such as Theory of Planned Behaviour messages (Table 1), increasing the difference between total and analysed samples. The participants included in these groups do not feature in this analysis as only the control groups and implementation intention groups were used for the analysis. In total, a sample of 2055 was analysed for the alcohol use outcome and 703 for the smoking outcome.

3.3 Characteristics of the participants

The two main populations recruited within the selected studies were students ($k=11$) and the general population ($k=10$). The total mean age of the sample ranged from 16.6 to 43.7 ($M=26.97$, $SD=8.69$, $k=20$). A slightly higher percentage of women was generally included in the studies, ranging from 43 to 76% ($M=59.03\%$, $SD=9.95$, $k=22$).

3.4 Characteristics of substance use outcomes

Most studies measuring alcohol use outcomes used self-reported weekly or daily consumption or binge drinking occasions ($k=14$). One study (Ehret and Sherman, 2018) used the Daily Drinking Questionnaire (Collins et al., 1985). The studies measuring tobacco smoking outcomes tended to use a mixture of self-report on cigarettes a day and quitting status ($k=6$), nicotine dependence score ($k=3$) and objective carbon monoxide (CO) breath tests (Matcham et al., 2014), a non-invasive procedure used for data validation.

3.5 Characteristics of implementation intention interventions

All studies referred to Gollwitzer's (1993) principles of implementation intentions. Implementation intentions were characterised mainly by two features. All implementation intentions were delivered after other questionnaires, such as demographic information or self-affirmation messages. The first feature to characterise the intervention was type of implementation intentions: self-generated ($k=10$) or pre-specified plans ($k=12$). The second feature was mode of delivery: delivered online on a computer screen (in person or remotely; $k=5$) or delivered in person on paper ($k=17$).

3.6 Risk of bias within studies

Risk of bias in individual studies was assessed with the SIGN checklist 2 for randomised controlled trials (SIGN, 2018). One reviewer (R1) completed the quality appraisal for all studies. A second reviewer (R2) appraised 13 studies whilst a third reviewer (R3) appraised 10 studies (McHugh, 2012). There was a substantial inter-rater agreement between R1 and

R2, with $K=0.64$, $p<.001$ ($n=143$), and a moderate inter-rater agreement between R1 and R3, with $K=0.54$, $p<.001$ ($n=110$). Disagreement or discrepancies were resolved by discussion (See Table 2).

3.7 Synthesis of results

The effectiveness of implementation intention was analysed by behavioural outcome and described in the paragraphs below. The intervention effectiveness was calculated between-groups at follow-up.

3.7.1 Alcohol consumption

Firstly, data was pooled from 16 studies that reported unadjusted data (Arden and Armitage, 2012; Armitage, 2009; Armitage, 2015; Armitage and Arden, 2012; Armitage and Arden, 2016a; Armitage and Arden, 2016b; Armitage et al., 2011; Armitage et al., 2014; Caudwell et al., 2018; Ehret and Sherman, 2018; Hagger et al., 2012a; Hagger et al., 2012b (3 samples); Murgraff et al., 2007; Ravis et al., 2013) and included 2055 individuals (students and general population). The effect size for alcohol use was $g=0.31$ (95% CI: 0.21, 0.42), $p<.001$, indicating that implementation intentions had a small but significant effect in reducing alcohol consumption (Figure 2). The statistical heterogeneity across the studies was not significant ($Q_{\text{statistic}}=18.39$; $df=15$; $I^2=18.41\%$; $p=.24$).

3.7.2 Tobacco Smoking

Data was pooled from 6 studies (Armitage, 2007; Armitage, 2008; Armitage, 2016; Armitage and Arden, 2008; Matcham et al., 2014; Webb et al., 2009) and included 703 individuals. A small effect size was detected, with $g=.31$ (95% CI: 0.12, 0.5), $p=.002$, indicating that implementation intentions had a small effect on reducing tobacco smoking (Figure 3). The homogeneity analysis suggested a moderate, yet non-significant degree of statistical heterogeneity ($Q_{\text{statistic}}=9.9$; $df=5$; $I^2=49.49\%$; $p=.08$).

3.7.3 Illicit drug use

No studies that fitted the inclusion criteria were found in the present systematic search for the use of implementation intentions on reduction of illicit drug use. Literature suggests implementation intentions should be employed to prevent and treat addiction (Prestwich et al., 2006), yet more research is undoubtedly needed in this area. The lack of literature on this topic could also be due to publication bias, favouring publication of significant results.

3.8 Risk of bias across studies

3.8.1 Assessment of publication bias.

Funnel plots for the studies reporting alcohol and tobacco smoking follow-up effect sizes were visually inspected to assess publication bias, with no obvious bias detected (see supplementary file 3)⁵. Eggers regression test (Egger et al., 1997) showed no evidence of publication bias among the studies reporting alcohol use (intercept=0.4; SE=1.25; 95% CI: -2.28, 3.08) and among those reporting tobacco smoking (intercept=-2.33; SE=1.89; 95% CI: -7.57, 2.91). Furthermore, the trim and-fill method (Duval and Tweedie, 2000) suggested that no missing studies were needed to make the plot symmetric for the tobacco smoking outcome. Nevertheless, it suggested the inclusion of an extra 2 studies for greater symmetry for the alcohol outcome. This simply estimates that the addition of 2 unpublished studies would increase the symmetry of funnel plot, showing slight publication bias towards studies with positive medium effect sizes.

3.8.2 Sensitivity analyses

Sensitivity analyses were used to remove individual studies with high relative weight to investigate the robustness of the overall results. For the alcohol outcome, two studies (Armitage et al., 2011; Rivis et al., 2013) were found to influence the meta-analysis results

⁵ Supplementary material can be found by accessing the online version of this paper at <http://dx.doi.org> and by entering doi: ..

more than other studies. When Armitage et al. (2011) was omitted from the analysis, a slight reduction in pooled effect size was observed, $g=0.28$ (95% CI: 0.18, 0.39), $p<.001$. When Ravis et al. (2013) was omitted from the analysis, a slight increase in pooled effect size was observed, $g=0.33$ (95% CI: 0.21, 0.44), $p<.001$. Opposite effects were observed on the pooled effect size, with one study increasing and the other decreasing such value, confirmed by further analysis in which both studies were omitted and the effect size returned to be similar to the original pooled value, $g= 0.3$ (95% CI: 0.19, 0.41), $p<.001$.

For the tobacco smoking outcome, one study (Armitage and Arden 2008) was omitted, providing a slightly smaller effect size, $g=0.25$ (95% CI: 0.02, 0.48), $p=.031$.

4 Discussion

This meta-analysis reviewed the evidence of the effectiveness of implementation intention on the reduction of substance use. It found a small, yet significant, effect size for both alcohol use and tobacco smoking. The Hedges' g values reported in this meta-analysis are smaller than the medium effect size of $d = 0.65$ reported in a highly cited meta-analysis of behaviour change studies (Gollwitzer and Sheeran, 2006). The results are, however, similar to other meta-analyses investigating the effectiveness of implementations intentions on specific health behaviour, such as promoting physical activity, $SMD= 0.24$ (Bélanger-Gravel et al., 2013), and reducing unhealthy eating, $d=0.29$ (Adriaanse et al., 2011).

The results of this meta-analysis suggest that implementation intentions have been successfully applied to some substance use behaviours such as alcohol consumption and tobacco smoking, implying that the automaticity aspect of implementation intentions could function as the mechanism of behaviour change. The results for the alcohol use outcome were consistent throughout the sensitivity analyses, suggesting a degree of confidence in the strength of the findings. The number of studies included for this outcome ($k=16$) and the

general high quality of the studies presented, contributed to the strength of the findings. The strength of the findings on the tobacco smoking outcome was slightly less consistent due to the low number of studies identified for the meta-analysis ($k=6$). However, the results are in line with previously published literature on effectiveness of implementation intentions (Adriaanse et al., 2011; Bélanger-Gravel et al., 2013; Kwasnicka et al., 2013).

In some of the included studies, implementation intention interventions were coupled or provided alongside other behaviour change techniques (BCTs), such as self-affirmation manipulations, social comparisons and information about social and environmental consequences or mental rehearsal of successful performance . It is possible that the effect sizes reported in the findings of this review might have been influenced by more than one BCT. This is the nature of social and health psychological research, presenting research with possible confounders given ‘laboratory’ experimental conditions are unnatural and arguably lack ecological validity (Orne, 1962).

Regrettably, this review was unable to analyse whether implementation intentions interventions can reduce illicit drug use. The lack of identifiable studies on this subject is surprising, highlighting a need for this type of research to be conducted. Given the interest this topic had raised in previous years (Brandstätter, Lengfelder & Gollwitzer, 2001; Churchill and Jessop, 2010; Prestwich et al., 2006; Verdejo-García et al., 2008), it is possible studies have been conducted, but have been victim of publication bias, where studies with no significant effects have failed to be published and distributed to the wider scientific community.

4.1 Implications for practice

The damaging effects on health of substance use, such as alcohol and tobacco smoking, and their related mortality rates, were explored in detail at the start of this paper. Implementation intentions are a brief, one-off and inexpensive intervention that can be provided by primary

and secondary care healthcare providers alike. They provide individuals with self-regulatory strategies to automatically initiate action planning after experiencing environmental cues. Given the small significant effect sizes and the characteristics of study participants, it is unclear what the implications from this review may be for clinical practice. Therefore future research on implementation intentions should test them as part of clinical practice with patients in alcohol use and smoking cessation settings.

4.2 Limitations

At a study level, this review did not exclude studies with high risk of bias. Only RCTs were included in the review, in order to minimise risk of bias and increase confidence in the overall findings. However, studies which were found to have low methodological quality were retained in the review, which could have increased the risk of bias at review level. Equally, excluding these studies might have increased the risk of bias at review level by reporting only high-quality studies. A decision was made to keep all studies despite their individual risk of bias, as there was an identified need to translate the findings into real-world clinical application, allowing therefore for some methodological imperfections.

At review level, other limitations were also identified. Only 3 databases were searched for literature, no grey literature was reviewed and only one reviewer conducted the searches and identified the studies for quality appraisal. Grey literature is not peer reviewed and therefore was purposefully not included. Two clinical trial databases were searched for ongoing RCTs, yet only published trials were identified with this search. Reference lists searches were conducted and proved fruitful.

All populations included in the studies analysed were from Western societies. High-income Western countries may have a very different cultural relationship with substance use compared to low- and middle-income countries in other parts of the world. Further research

which elucidates whether the automaticity of action planning initiation following environmental cues can differ between cultures should be conducted.

Lastly, the reviewers observed some heterogeneity with regards to implementation intentions intervention delivery, yet when I^2 and $Q_{statistic}$ tests were run to assess heterogeneity between studies, only the smoking outcome showed a somewhat moderate level of non-significant heterogeneity. All data was checked to be correct and this analysis was reported, as some degree of heterogeneity is to be expected in meta-analysis (Higgins, 2008).

4.3 Conclusions

This meta-analysis suggests that implementation intention interventions show significant small effects in reducing some forms of substance use (alcohol use and tobacco smoking) among the general population and students in secondary and higher education. The evidence of the effectiveness of this intervention could be improved by standardising implementation intention interventions (oral or written, self-generated or pre-specified, implementation intention seen once or with repeated exposure). Generalisability could be improved by conducting interventions in clinical populations and in low- to middle-income countries with different cultural views on substance use. Future research efforts should also be applied on the use of implementation intentions to reduce illicit drug use, whether or not the effect of this intervention is significant, and on the use of implementation intentions in clinical practice.

Data Availability Statement

Data supporting the findings of this study are available in Open Science Framework at https://osf.io/gta24/?view_only=f78d38ccd2ab4cc99ae0b7d87ff47ec9.

References

*Articles included in the present systematic review

Aarts, H., Dijksterhuis, A. P. and Midden, C. , 1999. To plan or not to plan? Goal achievement or interrupting the performance of mundane behaviors. *Eur. J. Soc. Psychol.* 29, 971-979.

Adriaanse, M. A., Vinkers, C. D. W., De Ridder, D. T. D., Hox, J. J. and De Wit J. B. F., 2011. Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite*, 56, 183-193.

Ajzen, I., 1991. The theory of planned behaviour. *Organ. Behav. Hum. Decis. Process.* 50: 179-211.

American Psychological Society Publications and Communications Board Working Froup on Kournal Article Reporting Standards (APA), 2008. Reporting standards for research in psychology: Why do we need them? What might they be? *Am. Psychol.*, 63, 848-849.

*Arden, M. A. and Armitage, C. J., 2012. A Volitional help sheet to reduce binge drinking in students: a randomized exploratory trial. *Alcohol Alcohol.* 47, 156-159.

*Armitage, C. J., 2007. Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioural and implementation intentions. *J. Occup. Health Psychol.* 12, 376-390.

*Armitage, C. J., 2008. A volitional help sheet to encourage smoking cessation: a randomised exploratory trial. *Health Psychol.* 27, 557-566.

*Armitage, C. J., 2009. Effectiveness of experimenter-provided and self-generated implementation intentions to reduce alcohol consumption in a sample of the general populations: a randomized exploratory trial. *Health Psychol.* 28, 545-553.

*Armitage, C. J., 2015. Evidence that a volitional help sheet reduces alcohol consumption among smokers: a pilot randomized controlled trial. *Behav. Ther.* 46, 342-349.

- *Armitage, C. J., 2016. Evidence that implementation intentions can overcome the effects of smoking habits. *Health Psychol.*, 35, 935-943.
- *Armitage, C. J. and Arden, M. A., 2008. How useful are the stages of change for targeting interventions? Randomized test of a brief intervention to reduce smoking. *Health Psychol.* 27, 789-798.
- *Armitage, C. J. and Arden, M. A., 2012. A volitional help sheet to reduce alcohol consumption in the general population: a field experiment. *Prev. Sci.* 13, 635-643.
- *Armitage, C. J. and Arden, M. A., 2016. Enhancing the effectiveness of alcohol warning labels with a self-affirming implementation intention. *Health Psychol.* 35, 1159-1163.
- *Armitage, C. J., Harris, P. R. and Arden, M. A., 2011. Evidence that self-affirmation reduces alcohol consumption: randomized exploratory trial with a new, brief means of self-affirming. *Health Psychol.* 30, 633-641.
- *Armitage, C. J., Rowe, R., Arden, M. A. and Harris, P. R., 2014. A brief psychological intervention that reduces adolescent alcohol consumption. *J. Consult. Clin. Psychol.* 82, 546-550.
- Bahorik, A. L., Satre, D. D., Kline-Simon, A. H., Weisner, C. M. and Campbell C. I., 2017. Alcohol, Cannabis, and Opioid Use Disorders, and Disease Burden in an Integrated Healthcare System. *J. Addict. Med.* 11, 3-9.
- Begg, C. B. and Mazumdar, M., 1994. Operating characteristics of a rank correlation test for publication bias. *Biometrics*, 50, 1088-1101.
- Bélanger-Gravel, A., Godin, G. and Amireault, S., 2013. A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychol. Rev.* 7, 23-54.

- Bolman, C., Eggers, S. M., van Osch, L., Poel, F. T., Candel, M. and de Vries, H., 2015. Is action planning helpful for smoking cessation? Assessing the effects of action planning in a web-based computer-tailored intervention. *Subst. Use Misuse*, 50, 1249-1260.
- Borenstein, M., Hedges, V., Higgins, J. P. and Rothstein, H. R., 2009. *Introduction to meta-analysis*. John Wiley & Sons Ltd., Chichester, UK.
- Brandstätter, V., Lengfelder, A. and Gollwitzer, P. M., 2001. Implementation intentions and efficient action initiation. *J. Pers. Soc. Psychol.*, 81, 946-960.
- *Caudwell, K. M., Mullan, B. A. and Hagger, M. S., 2018. Testing an online, theory-based intervention to reduce pre-drinking alcohol consumption and alcohol-related harm in undergraduates: a randomized controlled trial. *Int. J. Behav. Med.* 25, 592-604.
- Churchill, S. and Jessop, D. C., 2011. Too impulsive for implementation intentions? Evidence that impulsivity moderates the effectiveness of an implementation intention intervention. *Psychol. Health*, 26, 517-530.
- Cohen, J., 1988. *Statistical power analysis for the behavioural sciences*. Lawrence Earlbaum Associates, Hillside, New Jersey.
- Collins, R. L., Parks, G. A. and Marlatt, G. A., 1985. Social determinants of alcohol consumption: the effects of social interaction and model status on the self-administration of alcohol. *J. Consult. Clin. Psychol.*, 53, 189-200.
- *Conner, M. and Higgins, A. R., 2010. Long-term effects of implementation intentions of prevention of smoking uptake among adolescents: a cluster randomized controlled trial. *Health Psychol.* 29, 529-538.

- Cooper, H., Hedges, L. V. and Valentine, J. C., 2009. *The Handbook of Research Synthesis and Meta-analysis*. Russell Sage Foundation, New York City, USA.
- Duval, S. J. and Tweedie, R. L., 2000. A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. *J. Am. Stat. Assoc.* 95, 89–98.
- Egger, M., Davey-Smith, G., Schneider, M., and Minder, C., 1997. Bias in meta-analysis detected by a simple graphical test. *BMJ*, 315, 629-35.
- *Ehret, P. J. and Sherman, D. K., 2018. Integrating self-affirmation and implementation intentions: effects on college student drinking. *Ann. Behav. Med.* 52, 633-644.
- Gollwitzer, P. M. and Sheeran, P., 2006. Implementation intentions and goal achievement: A meta-analysis of effect and processes. *Adv. Exp. Soc. Psychol.* 38: 69-119.
- *Hagger, M. S., Lonsdale, A. and Chatzisarantis, N. L. D., 2012a. A theory-based intervention to reduce alcohol drinking in excess of guideline limits among undergraduate students. *Br. J. Health Psychol.* 17, 18-43.
- *Hagger, M. S., Lonsdale, A., Koka, A., Hein, V., Pasi, H., Lintunen, T., Chatzisarantis, N. L. D., 2012b. An intervention to reduce alcohol consumption in undergraduate students using implementation intentions and mental simulations: a cross-national study. *Int. J. Behav. Med.* 19, 82-96.
- Hedges, L. V. And Vevea, J. L., 1998. Fixed- and random-effects models in meta-analysis. *Psychol. Methods*, 3, 486-504.
- Higgins, J. P. T., 2008. Commentary: heterogeneity in meta-analysis should be expected and appropriately quantified. *Int. J. Epidemiol.* 37, 1158–1160.

Higgins, J. P. T. and Green, S. (editors), 2011. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Accessed online on 12/11/18 at handbook-5-1.cochrane.org

Hodder, R. K., Freund, M., Bowman, J., Wolfenden, L., Gillham, K., Dray, J. and Wiggers, J., 2016. Association between adolescent tobacco, alcohol and illicit drug use and individual and environmental resilience protective factors. *BMJ Open*, 6, e012688.

International Alliance for Responsible Drinking – IARD, 2018. Drinking guidelines: General population. Accessed online on 30/11/18 at iard.org/resources/drinking-guidelines-general-population/

Kwasnicka, D., Pesseau, J., White, M. and Sniehotta, F. F., 2013. Does planning how to cope with anticipated barriers facilitate health-related behaviour change? A systematic review. *Health Psychol. Rev.* 7, 129-145.

Landis, J. R. and Koch, G. G., 1977. The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-174.

Latka, M. H., Hagan, H., Kapadia, F., Golub, E. T., Bonner, S., Campbell, J. V., Coady, M. H., Garfein, R. S., Pu, M., Thomas, D. L., Thiel, T. K. and Strathdee, S. A., 2008. A Randomized Intervention Trial to Reduce the Lending of Used Injection Equipment Among Injection Drug Users Infected With Hepatitis C. *Am. J. Public Health*, 98, 853-861.

*Matcham, F., McNally, L. and Vogt, F., 2014. A pilot randomized controlled trial to increase smoking cessation by maintaining National Health Service Stop Smoking Service attendance. *Br. J. Health Psychol.* 19, 795-809.

- McHugh, M. L., 2012. Inter-rater reliability: The kappa statistic. *Biochem. Med.* 22, 276-282.
- Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J. and Wood, C. E. 2013. The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. *Ann Behav Med*, 46: 81-95.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G. and The PRISMA Group, 2009. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* 6, e1000097.
- *Murgraff, V., Abraham, C. and McDermott, M., 2007. Reducing Friday alcohol consumption among moderate, women drinkers: evaluation of a brief evidence-based intervention. *Alcohol Alcohol.* 42, 37-41.
- *Norman, P. and Wrona-Clarke, A., 2016. Combining self-affirmation and implementation intentions to reduce heavy episodic drinking in university students. *Psychol. Addict. Behav.* 30, 434-441.
- *Norman, P., Cameron, D., Epton, T., Webb, T. L., Harris, P. R., Millings, A. and Sheeran, P., 2018. A randomized controlled trial of a brief online intervention to reduce alcohol consumption in new university students: Combining self-affirmation, theory of planned behaviour messages, and implementation intentions. *Br. J. Health Psychol.* 23, 108-127.
- Prestwich, A., Conner, M. and Lawton, R. J., 2006. Implementation Intentions: Can they be used to prevent and treat addiction?. In Wiers, R. W. and Stacy, A. W. (Eds). *Handbook of Implicit Cognition and Addiction* (455-470). SAGE Publications Inc., Thousand Oaks, California, US.

- Puhan, M. A., Soesilo, I., Guyatt, G. H. and Schünemann, H. J., 2006. Combining scores from different patient reported outcome measures in meta-analyses: when is it justified? *Health Qual. Life Outcomes*, 4, 1-8.
- *Rivis, A. and Sheeran, P., 2013. Automatic risk behaviour: direct effects of binge drinkers stereotypes on drinking behaviour. *Health Psychol.* 32, 571-580.
- Robles, R. R., Reyes, J. C., Colón, H. M., Sahai, H., Marrero, A., Mator, T. D., Calderón, J. M. and Shepard, E. W., 2004. Effects of combined counseling and case management to reduce HIV risk behaviors among Hispanic drug injectors in Puerto Rico: A randomized controlled study. *J. Subst. Abuse Treat.* 27, 145-152.
- Ronksley, P. E., Brien, S. E., Turner, B. J., Mukamal, K. J. and Ghali, W. A., 2011. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. *BMJ*, 342, d671.
- Schuckit, M., 2009. Alcohol-use disorders. *Lancet*, 373, 493-501.
- Scottish Intercollegiate Guidelines Network – SIGN, 2018. Critical appraisal notes and checklists. Accessed online on 06/09/2018 at sign.ac.uk/checklists-and-notes.html
- Sheeran, P., 2002. Intention-behaviour relations: A conceptual and empirical review. *Eur. Rev. Soc. Psychol.* 12, 1-36.
- Sheeran, P., Milne, S., Webb, T. L. and Gollwitzer, P. M., 2005. Implementation intentions and health behaviour. In Conner, M. and Norman, P. (Eds): *Predicting health behaviour*, second edition, 276-323. Open University Press: Maidenhead.
- Siu, N. Y. F., Lam, H. H. Y., Le, J. J. Y. and Przepiorka, A. M., 2014. Time perception and time perspective differences between adolescents and adults. *Acta Psychol.* 151, 222-229.

- Steinberg, L., Graham, S., O'Brien, L., Woolard, J., Cauffman, E. and Banich, M., 2009. Age Differences in Future Orientation and Delay Discounting. *Child Dev.* 80, 28-44.
- Sutton, A. J., Abrams, K. R. and Jones, D. R., 2001. An illustrated guide to the methods of meta-analysis. *J. Eval. Clin. Pract.* 7, 135-148.
- Sutton, S., 1998. Predicting and Explaining Intentions and Behavior: How Well Are we Doing? *J. Appl. Soc. Psychol.* 28, 1317-1338.
- Verdejo-García, A., Lawrence, A. J., Clark, L., 2008. Impulsivity as a vulnerability marker for substance-use disorders: Review of findings from high-risk research, problem gamblers and genetic association studies. *Neurosci. Biobehav. Rev.* 32, 777-810.
- *Webb, T. L., Sheeran, P. and Luszczynska, A., 2009. Planning to break unwanted habits: habit strength moderates implementation intention effects on behaviour change. *Br. J. Soc. Psychol.* 48: 507-523.
- World Health Organisation – WHO, 2014a. Global status report on noncommunicable diseases 2014:“Attaining the nine global noncommunicable diseases targets; a shared responsibility”. Geneva.
- World Health Organisation – WHO, 2016. Cannabis. The health and social effects of non-medical cannabis use. Accessed online on 30/11/18 at who.int/substance_abuse/publications/en
- World Health Organisation –WHO, 2018a. Global status report on alcohol and health 2018. Geneva, Licence: CC BY-NC-SA 3.0 IGO.

Table 1: Table 1: Summary table of characteristics of studies included in the meta-analysis ($k=22$)

Authors (year)	Study Design (group types)	Follow up period	Sample characteristics	Behavioural goal	Implementation intentions format	Measures of substance use reduction	Effect size (Hedge's g) [95%CI]
Arden & Armitage (2012)	RCT (2x control groups and 1x II)	2 weeks	56 students; Age: 20.57y (1.9); 66.1% ♀; UK	Reduce alcohol consumption	Pen and paper, pre-specified situation and solutions.	Alcohol consumption Units/week, binge drinking occasions	Combined $g= 0.64$ [0.21; 1.07]
Armitage (2007)	RCT	2 months	90 adults; Age: 33y (13); 45.56% ♀; UK	Reduce tobacco smoking	Pen and paper for one self-generated plan.	Nicotine dependence, N of quitters	Combined $g=0.47$ [0.08; 0.85]
Armitage (2008)	RCT (2 intervention x2 control)	1 month	193 adults; Age: 37y (14.6); 51.8% ♀; UK	Reduce tobacco smoking	Pen and paper, pre-specified situation and solutions.	Cigarettes/day, nicotine dependence , N of quitters	Combined $g=0.57$ [0.23; 0.9]
Armitage (2009)	RCT (2 intervention x2 control)	1 month	248 adults; Age: 38.4y (15.46); 50.4% ♀; UK	Reduce alcohol consumption	Pen and paper form. Plans pre-specified/self-generated in the written form	Alcohol consumption Units/day	$g= 0.3$ [-0.06; 0.66]

Armitage (2015)	RCT (Intervention, Active control)	1 month	65 adults; Age: 33.77y (9.69); 56.9% ♀; UK	Reduce alcohol consumption	Pen and paper form. Control asked to tick pre-specified VHS, intervention to link	Alcohol consumption Units/week	g= 0.13 [-0.35; 0.61]
Armitage (2016)	RCT 4 groups (if-then, when-then, 2 x control)	1 month	168 adults; Age: 33y (12.30), 47.01% ♀; UK	Reduce tobacco smoking	Pen and paper, pre-specified situation and solutions.	Quitting, cigarettes/day	g=-0.01 [-0.43; 0.41]
Armitage & Arden (2008)	RCT (2x control groups and 1x II)	2 months	350 adults; Age: 36.20y (14.3); 50.6% ♀; UK	Reduce tobacco smoking	Pen and paper, self-generated plan	Quitting and nicotine dependence score	Combined g= 0.46 [0.26; 0.67]
Armitage & Arden (2012)	RCT (2 CP (multiple or single) x II x active control	3 months	69 adults; Age: 38.51y (16.34); 52.2% ♀; UK	Reduce alcohol consumption	Pen and paper, pre-specified situation and solutions.	Alcohol consumption in Units	g= 0.54 [-0.13; 1.2]

Armitage & Arden (2016)	2-study RCT	1 month	Adults & students; UK	Reduce alcohol consumption	Self-affirming pre-specified intention	Alcohol consumption in Units/Week	<u>Study 1</u> g= 0.59 [0.16; 1.02]
			<u>Study 1</u> : N= 85 Age 23.69y (3.61); 62.38% ♀; <u>Study 2</u> : N= 58 Age: 19.38y (0.9); 75.86% ♀;				<u>Study 2</u> g= 0.47 [-0.04; 0.99]
Armitage et al. (2011)	RCT (2 experimental, 1 control)	1 month	278 adults; Age Range 16-74; 66.2% ♀; UK	Reduce alcohol consumption	Pen and paper form. Pre-specified plans but participants had to write them down as one sentence (not link them)	Alcohol consumption in Units/Day	g= 0.57 [0.28; 0.86]
Armitage et al. (2014)	RCT (experimental and control group)	2 months	67 adolescents; Age: 17.09y (0.38); 55.22% ♀; UK	Reduce alcohol consumption	Pen and paper form. Pre-specified plans but participants had to write them down as one sentence	Alcohol consumption in Units/Day	g=0.19 [-0.29; 0.66]
Caudwell et al. (2018)	RCT (2 autonomy support x 2 II)	4 weeks	202 students; Age: 20.95y (4.02); 73% ♀ Australia	Reduce alcohol consumption	Online, to use example given or elf-generate plan.	Weekly pre-drinking summed to create monthly score	g=0.07 [-0.43; 0.56]

Conner & Higgins (2010)	RCT (II, self-efficacy intervention, 2 control conditions)	48 months	1551 adolescents; Mean age NR; 48.9% ♀; UK	Reduce tobacco smoking	Pen and paper, 5 x pre-specified plans	Jarvis (1997) self-report smoking measure or objective carbon monoxide breathalyser. Binary variable.	$g=0.24 [-2.64; 3.12]$
Ehret & Sherman (2018)	RCT (II, self-aff, control, II+self-aff)	2 weeks	293 college students; Mean age NR; 70% ♀; USA	Reduce alcohol consumption	On screen in lab. Self-generated plans.	Typical drinking week measured with Daily Drinking Questionnaire;	$g=0.26 [-0.08; 0.59]$
Hagger et al. (2012a)	Cluster RCT 2x2 (mental simulation; II)	1 month	238 undergraduate students; Age: 20.35y (2.51); 58% ♀; UK	Reduce alcohol consumption	Online, self-generated plans + self-affirmation manipulation.	Alcohol consumption in Units/Week & binge drinking occasions	Combined $g=0.25 [-0.16; 0.66]$

Hagger et al. (2012b)	Multi-centred Full-factorial RCT 2x2 (mental stimulation; impl intentions)	1 month	718 undergraduate students (240 Estonia, 194 Finland, 284 UK); Age: 21.37y (SD range= 2.7-4.28); 74% ♀	Reduce alcohol consumption	Pen and paper, self-generated plans.	Alcohol consumption in Units/week and binge drinking occasions	UK sample Combined g= 0.35 [0.06; 0.65] Estonian sample Combined g= 0.31 [0.02; 0.6] Finnish sample Combined g= -0.16 [-0.49; 0.18]
Matcham et al. 2014	RCT 2x2 (effectiveness booklet and/or/not II)	4 weeks	160 adults; Age: 43.7y (14.2); 54.4% ♀; UK	Reduce tobacco smoking	Pre-specified plans written on paper but repeated orally.	Self-report 4-week quit status (and CO breath test where possible)	g= 0.06 [-0.4; 0.53]
Murgraff et al. (2007)	RCT	8 weeks	347 students; Age: 26y (SD NR) 73.2% ♀; UK	Reduce alcohol consumption	A4 paper sheet with recommended daily units + statements of normative misperceptions + statements to boost self-efficacy + 6 pre-specified plans.	Alcohol consumption on Friday (units)	g=0.44 [0.09; 0.8]

Norman & Wrona-Clarke (2016)	Cluster RCT 2x2 (mental simulation; II)	1 week	348 undergraduate students; Age: 22.58y (6.31); 64.1% ♀; UK	Reducing alcohol consumption	Online, self-generated plans + self-affirmation manipulation.	Alcohol consumption in Units/Week and binge drinking occasions	Combined g=0.19 [-0.04; 0.42] Adjusted data
Norman et al. (2018)	RCT (2 self-affirmation x 2 TPB messages x 2 II)	6 months	2682 students; Age: 18.76y (1.94); 53.8% ♀; UK	Reduce alcohol consumption	Online, self-generated plans.	Alcohol consumption in Units/week and binge drinking sessions	Combined g= -0.03 [-0.23; 0.17] Adjusted data
Rivis et al. (2013)	RCT (2 II x 2 stereotype evaluation)	1 month	202 pupils; Age: 16.62y (0.68); 55.4% ♀; UK	Reduce alcohol consumption	One pre-specified plan on paper read by participant 3 times	Binge drinking sessions	g=0.2 [-0.08; 0.47]
Webb et al. (2009)	RCT (1 intervention, 1 control)	1 month	172 students; Age: 18.49y (SD NR); 43% ♀; UK	Reduce tobacco smoking	Pen and paper. 4 pre specified situations, subjective solution. Seat belt control group.	Cigarettes/day	g= 0.11 [-0.19; 0.41]

Note: RCT - Randomised Controlled Trial; II - Implementation intentions; VHS - Volitional Help Sheet; NR – Not reported.

Table 2: Risk of bias

	Randomisation sequence concealment (selection bias)	Allocation concealment (selection bias)	Blinding of subjects and investigators (ascertainment bias)	Similarity in groups at baseline (selection bias)	Relevant, valid and reliable outcomes (measurement bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Overall quality
Arden & Armitage 2012	+	+	?	+	+	+	+	++
Armitage 2007	+	+	+	+	+	+	+	++
Armitage 2008	+	+	+	+	+	+	+	++
Armitage 2009	+	+	+	+	+	+	?	++
Armitage 2015	+	+	+	+	+	+	+	++
Armitage 2016	+	+	+	+	+	+	+	++
Armitage & Arden 2008	+	+	+	-	+	+	+	++
Armitage & Arden 2012	+	+	+	+	+	+	?	++
Armitage & Arden 2016	+	+	?	+	+	?	?	++
Armitage et al. 2011	+	+	+	+	+	+	+	++
Armitage et al. 2014	+	+	+	+	+	+	+	++
Caudwell et al. 2018	+	+	+	+	+	-	+	++
Conner & Higgins, 2010	+	+	-	-	+	-	+	+
Ehret et al. 2018	+	?	?	?	+	+	+	+
Hagger et al. 2012a	+	+	+	-	+	-	?	-
Hagger et al. 2012b	+	+	?	-	+	-	+	+
Matcham et al. 2014	+	-	-	?	+	?	+	+
Murgraff et al. 2007	+	-	?	?	?	-	?	-
Norman & Wrona-Clarke 2016	+	+	+	+	+	+	-	+
Norman et al. 2018	+	-	-	+	+	-	+	+
Rivis & Sheeran, 2013	+	?	?	+	?	-	?	-
Webb et al. 2009	+	+	+	+	+	+	+	++

Note: Quality assessed as: ++ (High quality); + (Acceptable); - (Low quality), ? (Can't say/Does Not Apply)